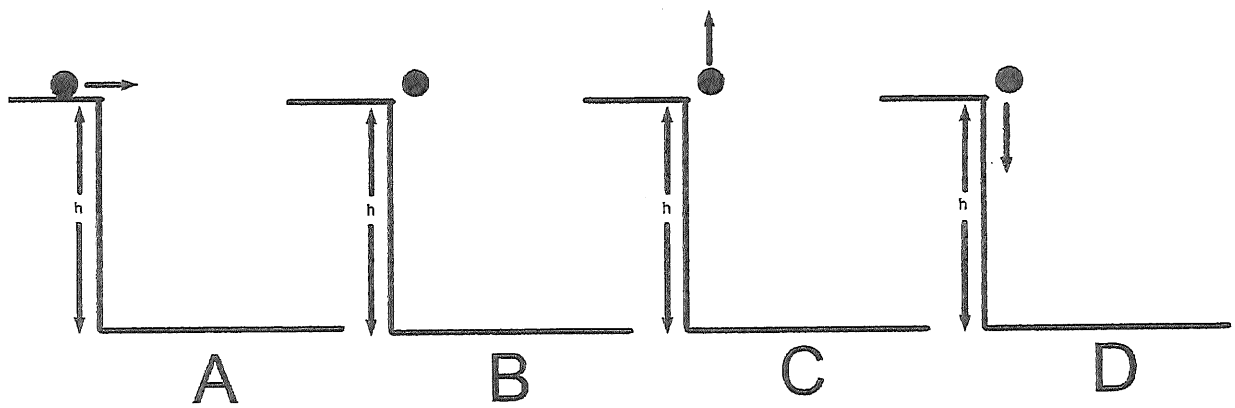
Projectile Motion- Horizontal



A 5kg ball is dropped off a cliff. The cliff is 50m high.

1. Scenario B is likely the simplest. The ball is simply dropped off the cliff.
   a. Determine the time for the ball to reach the bottom?

      $X_f = X_i + V_i t + \frac{1}{2} a t^2$
      $-50 = 0 + 0 + \frac{1}{2} (-9.8) t^2$ $t = 3.19$ sec.

   b. Determine the speed of the ball at the bottom?

      $V_f = V_i + at$
      $= 0 + 9.8(3.19) = 31.3$ m/s

   c. Student hypothesis: Half way down the cliff the speed Is half of "b". Justify or nullify this statement.

      Starting at zero, the ball faster in second half.

2. Scenario C has a ball that is thrown up at 20m/s, after which it falls down the 50m cliff.
   a. How high does the ball go?

      $V_f = V_i + at$
      $0 = 20 + -9.8t$ $t = 2.04$ sec to top

      $Y_f = Y_0 + V_i t + \frac{1}{2} a t^2$
      $= 0 + 20(2) + \frac{1}{2} (-9.8)(2)^2$
      40 − 19.6
      $Y_f = 20.2$ m above cliff

   b. How fast is the ball going just prior to impact?

      Total time — 70.2m

      $Y_f = Y_0 + V_i t + \frac{1}{2} a t^2$
      $-70 = 0 + 0 + \frac{1}{2} (-9.8) t^2$
      $t = 3.7$ sec. top to bottom

      $V_f = V_i + at$
      $0 + 9.8(3.77)$
      $V_f = 37$ m/s

3. Student hypothesis: Ball D will hit the ground first, but C and Ball D will be traveling the same speed at impact. Justify or nullify.

   True.

   Ball C, ↑ 20 ↓ 20 → 37 m/s

   Ball D ↓ 20 → 37 m/s

4. Scenario A is thrown off the edge at 20m/s horizontally of the 50m cliff.

a. Looking at model A, changes do you notice occurring and why?

Y velocity increases due to gravity

b. Gravity is a force affecting the (X, Y, both X/Y) directions in this situation?

only Y

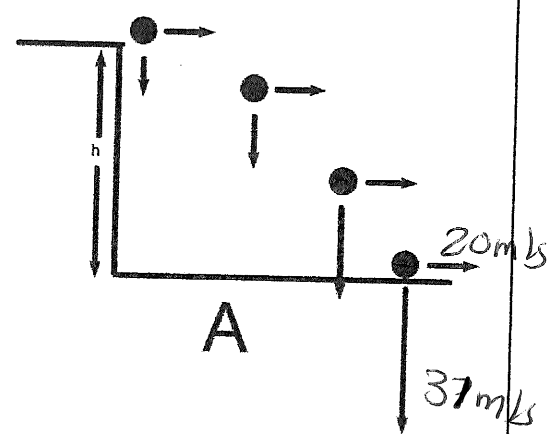
c. In the box to the lower right fill in what you know about each of the velocity vectors in model A.

the 31, same as B.
See B for Calc.

Note: This is a very common way to record down data for a multi-dimensional scenario.

Multi-component problem:

X and Y Components work independently



d. Determine the time in the air. **this is usually the first thing we do to solve these problems***

$Y_f = Y_0 + V_i t + \frac{1}{2} a t^2$

$-50 = 0 + 0 - \frac{1}{2} 9.8 t^2$ $t = 3.1$ sec

Note: the Y coordinate always controls time in the air!!!

X		Y	
X_0:	20	Yo:	0
V_i:	20	V_i:	0
a:	0	a:	-9.8
$t_?$:	3.1	$t_?$:	3.1
V_t:	20	V_t:	31

e. Fill out the rest of the table using time from "d".

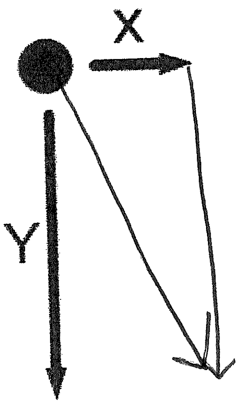
$V_f = 0 + 9.8 \cdot 3.1$

5. Student hypothesis: Kicking the ball twice as fast will cause the ball to farther and be in the air longer? Justify/nullify this statement.

Y componet does not change.
So, time in the air is the same.

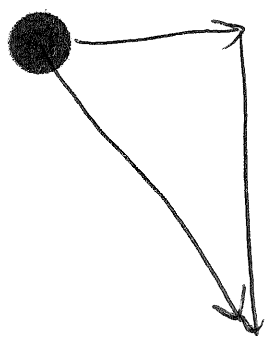
This ball has two velocities, one in the X direction and one in the Y direction. But what is the actual velocity of the ball?

6. Draw a vector (line with arrow) on the model showing the overall movement of the ball.



Vector addition
Hook tail to head

How do we add vectors together? (super important!) We have two methods.

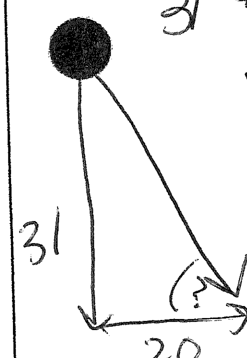


Hook "head to tail" and draw a line from the tail of one to the head of the other. Base upon scale of the line you can now measure the length of new line and its angle using a protractor. Do this now.

$31^2 + 20^2 = v^2$

$v^2 = 1361$

$v = 36\ m/s$



angle

$\tan\theta = \frac{31}{20}$

$\theta = 57°$

Hook "head to tail" and draw a line from the tail of one to the head of the other. Using the values you previously calculated the ***resultant*** using trigonometry and the Pythagorean theorem Do this now.

7. What is the in-line speed and angle of the resultant using both the X and Y components?